43. *Exhibition of Lance-headed Implements of Glass from Northwest Australia.* Sir W. W. TURNER.

44. *The Genesis of Implement-Making.* F. CUSHING.

Starting with the arboreal, artless precurser of man in southeastern tropical Asia, Mr. Cushing traced his development and extension after the acquisition of a larger brain, of the power to use the hand, of speech, etc., emphasizing the rôle of the psychic factor—the rule of the ideal instead of the physical, and the influence of seashore residence on primitive man. The passage from teeth and nails to shells and the passage of man through the pre-lithic and proto-lithic periods was indicated with numerous illustrative experiments and references to the investigations of the shell-heaps of Florida and Maine. It was a great triumph for man when he ceased to be a mere user of tools and came to make tools with tools.

45. *Adze-Making in the Andaman Islands* (lantern illustrations). PROFESSOR A. C. HADDON.

Professor A. C. Haddon exhibited a series of slides from photographs taken by Mr. Portman, showing the natives of the Andaman Islands in the various stages of manufacturing their adzes. It was a model series of anthropological photographs.

In the number and nature of the papers read, the discussions which followed them and the interchange, after the sessions were over, of thought and suggestions, the session was one of the most successful in the history of the Association.

The grants for anthropological research made by the General Association were as follows, the committees marked * having been reappointed:

* Tylor, Professor E. B.—Northwestern Tribes of Canada	£ 75 0 s.
* Munro, Dr. R.—Lake Village at Glastonbury	37 10
* Brabrook, Mr. E. W.—Ethnographical Survey (and unexpended balance in hand)	25 0
* Evans. Mr. A. J.—Silchester Excavation	7 10
* Dawson, Dr. G. M.—Ethnological Survey of Canada	75 0
Turner, Sir W.—Anthropology and Natural History of Torres Strait	125 0

A. F. CHAMBERLAIN.

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*ORGANIC SELECTION.**

THIS discussion was held before a joint afternoon session of the Zoological and Botanical Sections. At the close of Professor Poulton's paper he was obliged to withdraw. The question of the inheritance of acquired characters was taken up by Professor Theodore Gill, and a few remarks were made by Professor C. E. Bessey and others upon the botanical side.

Professor Osborn introduced the subject by a brief history of the progress of thought in recent years, dwelling especially upon the fact that ten years ago all the leading Darwinians had strenuously adhered to the original view of Darwin, that 'fortuitous variation' plays the most important part in the origin of new types, and that there was little evidence for 'determinate variation.' He continued as follows: The evidence for definite or determinate variation has always been my chief difficulty with the natural selection theory, and my chief reason for giving a measure of support to the Lamarckian theory. This evidence has steadily accumulated in botanical and zoological as well as paleontological researches, until it has come to a degree of demonstration where it must be reckoned with.

Quite in another field, that of experimental embryology and zoology, the facts of adaptation to new and untoward circumstances of environment have begun to

* A discussion introduced by Professor Henry F. Osborn and Professor Edward B. Poulton at the Detroit meeting of the American Association, Wednesday, August 11th.

constitute a distinct and novel series of problems. In many cases they are so remarkable and so unexplainable that certain German writers, such as Driesch, have taken the ground that they spring from the ultimate constitution of living matter and are incapable of analysis. At the same time it has been recognized that these adaptations are purely individual, transitory or ontogenic, leaving for a long time, at least, no perceptible influence upon the hereditary constitution of the organism. What may be called the 'traditional' side of these adaptations impressed itself strongly upon Professor James Mark Baldwin in his studies of mental development, also upon Professor Lloyd Morgan in his studies of instinct. The latter, moreover, was one of the first among English selectionists to consider 'determinate variation' as a fixed problem which must be included in any evolution theory. Thus, independently, Professors Baldwin and Morgan and myself put together the facts of individual adaptation with those of determinate variation into an hypothesis which is in some degree new. The first illustration which I used was that of the creation of an 'arboreal man' out of any present terrestrial race by the assumption of an exclusively tree life. This life would be profound in its influences upon each generation producing what would be pronounced by zoologists a distinct specific type. In course of many thousand years such a type might become hereditary by the slow accumulation of arboreal adaptive and congenital variations. The basal idea of it was contained in the Romanes Lecture by Weismann, but it was not brought out with emphasis, nor subsequently developed by that distinguished author.

The position taken by Poulton, Morgan and Baldwin that individual adaptation is in itself a result of natural selection cannot be demonstrated, except in cases where it is evident that such adaptation is in response to revived ancestral experience. In many instances, individual adaptation, as in cases of regeneration, is of advantage to the individual, but decidedly detrimental to the race, where it would result in the perpetuation of the progeny of a maimed or imperfect embryo.

Organic selection is the term proposed by Professor Baldwin and adopted by Professor Morgan and myself for this process in nature which is believed to be one of the true causes of definite or determinate variation. The hypothesis is briefly as follows: That ontogenetic adaptation is of a very profound character. It enables animals and plants to survive very critical changes in their environment. Thus all the individuals of a race are similarly modified over such long periods of time that very gradually congenital or phylogenetic variations, which happen to coincide with the ontogenetic adaptive variations, are selected. Thus there would result an apparent but not real transmission of acquired characters.

This hypothesis, if it has no limitations, brings about a very unexpected harmony between the Lamarckian and Darwinian aspects of evolution, by mutual concessions upon the part of the essential positions of both theories. While it abandons the transmission of acquired characters, it places individual adaptation first, and fortuitous variations second, as Lamarckians have always contended, instead of placing survival conditions by fortuitous variations first and foremost, as selectionists have contended.

This hypothesis has been endorsed by Alfred Wallace. It appears to me, however, that it is subject to limitations and exceptions which go far to nullify its universal application. This is especially seen in the fact that the law of determinate variation is observed to operate with equal

force in certain structures, such as the teeth, which are not improved by individual use or exercise, as in structures which are so improved. A very large class of determinate variations in other stationary characters, such as the inner parts of the skull, also remain unexplained. My study of teeth in a great many phyla of Mammalia in past times have convinced me that there are fundamental predispositions to vary in certain directions; that the evolution of the teeth is marked out beforehand by hereditary influences which extend back hundreds of thousands of years. These predispositions are aroused under certain exciting causes and the progress of teeth development takes a certain form converting into actuality what has hitherto been potentiality.

Edward B. Poulton, M. A., F. R. S., Hope Professor of Zoology in the University of Oxford, continued the discussion. He began by saying that it must be admitted that the adaptation of the individual to its environment during its own life-time possesses all the significance attributed to it by Professor Osborn, Professor Baldwin and Professor Lloyd Morgan. These authorities justly claim that the power of the individual to play a certain part in the struggle for life may constantly give a definite trend and direction to evolution, and that, although the results of a purely individual response to external forces are not hereditary, yet indirectly they may result in the permanent addition of corresponding powers to the species, inasmuch as they may render possible the operation of natural selection in perpetuating and increasing those inherent hereditary variations which go further in the same direction than the powers which are confined to the individual.

Professor Osborn's metaphor in opening this discussion puts the matter quite clearly and will be at once accepted by all Darwinians. If the human species were led by fear of enemies or want of food to adopt an arboreal life all the powers of purely individual adaptation would be at once employed in this direction and would produce considerable individual effects. In fact, the adoption of such a mode of life would at first depend on the existence of such powers. In this way natural selection would be compelled to act along a certain path, and would be given time in which to produce hereditary changes in the direction of fitness for arboreal life. These changes would probably at first be chiefly functional, as Mr. Cunningham has argued (in the Preface to his Translation of Eimer). On these principles we can understand the arboreal kangaroo (Dondrolagus) found in certain islands of the Malay Archipelago, which is apparently but slightly altered from the terrestrial forms found in Australia. Professor Osborn has alluded to the arboreal habits said to have been lately acquired by Australian rabbits; these and the similar modifications in habits of West Indian rats are further examples of individual adaptive modification which may well become the starting point (in the sense implied above) of specific variation led by natural selection in the definite direction of more and more complete adjustment to the necessities of arboreal life. Although this conclusion seems to me to be clear and sound, and the principles involved seem to constitute a substantial gain in the attempt to understand the motive forces by which the great process of organic evolution has been brought about, I cannot admit that the importance of natural selection is in any way diminished. I do not believe that these important principles form any real compromise between the Lamarckian and Darwinian positions, in the sense of an equal surrender on either side and the adoption of an intermediate position. The surrender of the Lamarckian position seems to me complete,

while the considerations now advanced only confer added significance and strength to Darwinian standpoint.

I propose to devote the remainder of the time at my disposal in support of the conclusion that the power of individual adaptation possessed by the organism forms one of the highest achievements of natural selection, and cannot in any true sense be considered as its substitute. Professor Baldwin and Professor Lloyd Morgan thoroughly agree with this conclusion and have enforced it in their writings on organic selection. The contention here urged is that natural selection works upon the highest organisms in such a way that they have become modifiable, and that this power of purely individual adaptability in fact acts as the nurse by whose help the species, as the above-named authorities maintain, can live through times in which the needed inherent variations are not forthcoming, but in part acts also as a substitute, not indeed for natural selection, but for the ordinary operation by which the latter produces change. In this latter case natural selection acts so as to produce a plastic adaptable individual which can meet any of the various forces to which it is likely to be exposed by producing the appropriate modification, and this, it is claimed, is in many instances more valuable than the more perfect, but more rigid, adjustment of inherent variations to a fixed set of conditions.

A good example of the eminent advantages of adaptability in many directions over accurate adjustment in fewer directions is to be found in a comparison between the higher parts of the nervous system in insects and birds. The insect performs its various actions instinctively and perfectly from the first. It is almost incapable of education and of modifying its actions as the result of the observation of the effects of some new danger. It would appear that the introduction of the electric light can only affect the insects which are most attracted to it, by the gradual operation of natural selection. In the clothes-moths, which infest our houses, we may see an example of this; for these insects seem to be comparatively indifferent to light. Birds, on the other hand, have the power of learning from experience, of reasoning from the results of observation. At first terrified by railway trains, they learn that they are not dangerous, and cease to be alarmed; while the effect of fire-arms results in their increased wariness.

If this view of individual adaptability as due to natural selection be not accepted, it may be supposed that the individual modifications are due either to the direct action of the external forces or to the tendencies of the organism. But it is impossible to understand how the mechanical operation of such forces as pressure, friction, stress, etc., continued through a lifetime, could evoke useful responses, or why the response should just attain and then be arrested at a level of maximum efficiency. The other supposition, that organisms are so constituted that they *must* react under external stimuli by the production of new, useful characters, or the useful modification of old ones, seems to me to be essentially the same as the old 'innate tendency toward perfection' as the motive cause of evolution—a conception which is not much more satisfactory than special creation itself. The inadequacy of these views is clearly shown when we consider that the external forces which awake response in an organism generally belong to its inorganic (physical or chemical) environment, while the usefulness of the response has relation to its organic environment (enemies, prey, etc.). Thus one set of forces supply the stimuli which evoke a response to another and very different set of forces. We can, therefore

accept neither of the suggestions which have been offered. Useful individual modifications are not directly due to the external forces, and are not due to the inherent constitution of the organism.

The only remaining hypothesis is that which I have already mentioned—the view that whenever organisms react adaptively under external forces they do so because of special powers conferred on them by natural selection. This hypothesis will, it seems to me, meet and satisfactorily explain all the facts of the case, whether employed as a preparation or as a substitute for hereditary variations accumulated by natural selection.

ASTROPHYSICAL NOTES.

IN the August number of the *Astrophysical Journal* Sir William and Lady Huggins publish a paper, read before the Royal Society in June, which throws light upon the perplexing behavior of the H and K lines of calcium in solar and stellar phenomena. It was early noted by Young that these lines were especially conspicuous in the spectrum of the solar chromosphere and prominences, while other calcium lines, strong in the ordinary solar spectrum, were seldom seen as bright lines. Recent researches with the aid of photography, chiefly by Hale, have still more emphasized the significant part played by these two radiations in chromosphere, prominences and faculæ. They rival those of hydrogen and helium in their prevalence and in the high elevations in the solar atmosphere in which they occur. It has therefore been the thought of many that possibly they are not due to calcium after all, but to some lighter gaseous element, existing as an undetected impurity in calcium, a view which after the discovery of argon in nitrogen would appear as not wholly unreasonable. Others have agreed with the opinion of Lockyer that at the excessive solar temperature the spectrum of calcium would become simplified so as to consist of but few lines, chiefly H and K, perhaps due to 'dissociation.'

The Huggins experiments now indicate, however, that the density is the determining factor, and they have succeeded in photographing in the laboratory a spectrum of calcium consisting solely of the H and K lines, with perhaps an analogous pair in the far ultra-violet region. This important result had hitherto not been accomplished by other investigators (although in retrospect, perhaps, it will appear that such plates have accidentally been secured), chiefly because the effort has been to use a spark of as high intensity as possible. The procedure now adopted consisted in taking the spectrum of a spark of feeble intensity passing between platinum electrodes which had been moistened with a solution of calcic chloride. Several *Ca* lines were present, but relatively to H and K the other lines were less intense than when electrodes of metallic calcium had been employed. On reducing the amount of calcium vapor present in the spark by successive washings of the electrodes in pure water the other lines retired, finally leaving only H and K.

These new results are confirmatory of the present view as to the extreme rareness of the vapors in the upper chromosphere, and may prove of much value in giving a criterion of the density of stellar atmospheres in the spectra of which the calcium lines appear in some of their different phases.

IN connection with the approaching dedication of the Yerkes Observatory, which will occur on October 21st and 22d, a series of conferences will be held (from October 18th to 21st) which promise to be of much interest to astrophysicists. An extensive